

## The new radar data processing software for the German Weather Radar Network

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**Abstract.** The radar data processing of the German Weather Radar Network is under way to be modernized by use of UNIX/LINUX platforms and “state of the art” weather radar application software. The GAMIC FROG-MURAN application suite will be used as new common software platform. FROG-MURAN is extended by additional features and functionality, custom made for DWD according to project specifications. The software system is capable to handle heterogeneous radar sensors in particular of two different vendors which are currently operational in the DWD network. FROG-MURAN for the DWD has been designed to interface to existing and future hardware sensor concepts to be deployed at DWD like digital receivers and dual polarization. The first software systems will be operational in 2002 at MOHP and other operational sites. This new DWD weather radar data system will be the source of high quality data for a wide range of scientific and operational users in Germany in the next decade.

### 1 Introduction: Weather radar at DWD – history and technical overview

DWD operates 16 C-Band weather radars linked together in a real-time radar network. At the MOHP research office an additional Doppler radar is used for validation of new systems and algorithms before these are deployed to the operation service.

#### 1.1 DWD radar network

The weather radar network of DWD was created to measure the 3-dimensional distribution of hydrometeors in the atmosphere over the German territory with high resolution in time and space. The weather radar network services the following users delivering data and products:

- Forecasting (Now-casting) DWD-internal and -external
- Hydro-meteorology and water management
- Numerical weather forecasting (data assimilation, validation)
- Research and development
- Other weather services

The goal of the weather radar network is to provide data with the highest quality to all customers. The quality of data is measured according to the following criteria:

- Contents of the product (Parameter, method of compilation and format)
- Accuracy (absolute and relative)
- Availability (space and time, absolute and relative)

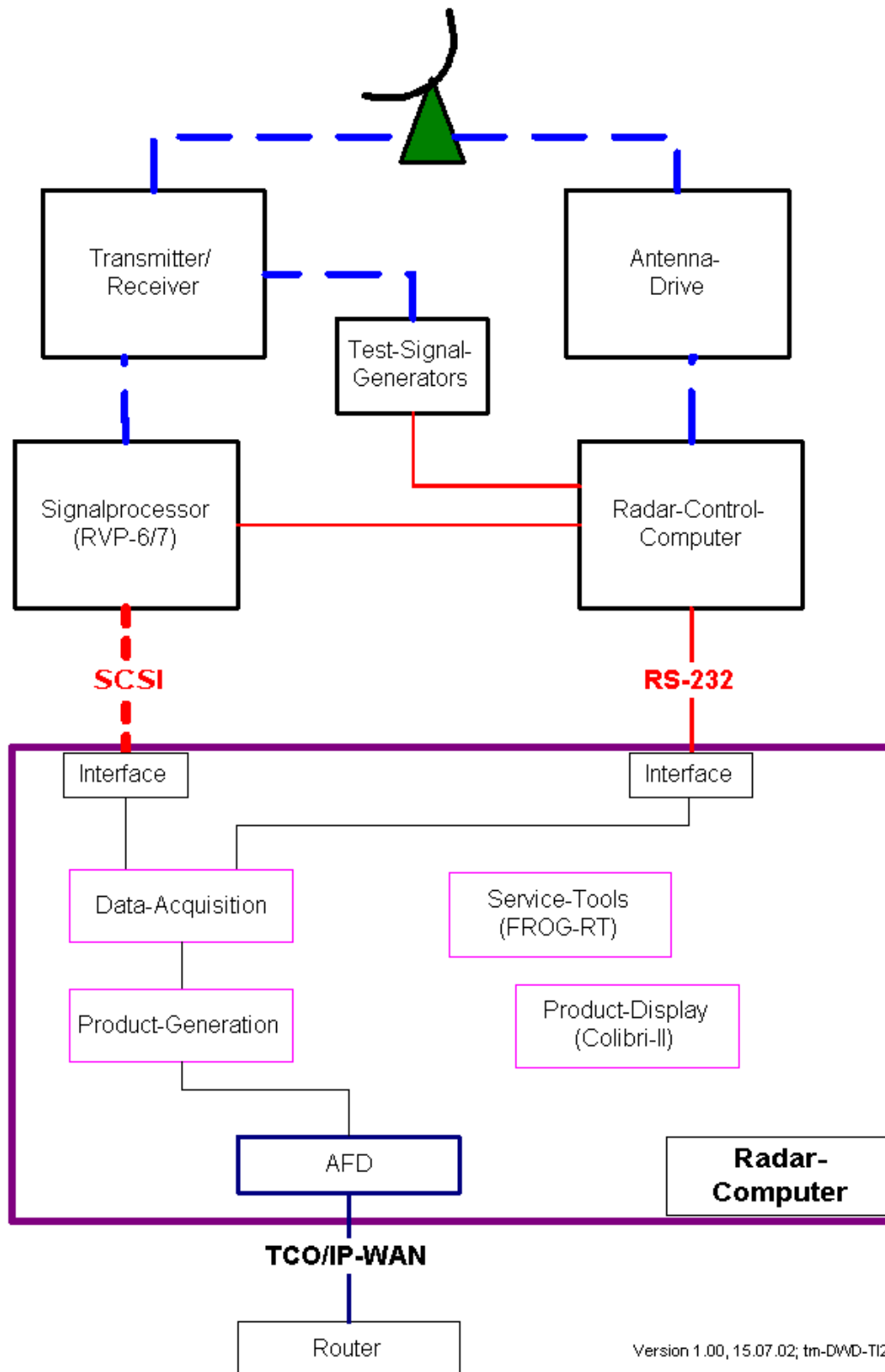
#### 1.2 Radar data acquisition

At each radar site volumetric data are acquired and pre-processed. 2-dimensional “DWD products” are generated and transmitted to users directly and the central office in Offenbach via AFD on a WAN.

#### 1.3 Current processing systems at radar sites

The pre-processing of the radar sweeps is performed by Signal Doppler processors, RVP-6 and -7. The preprocessed ray data are sent to the VAX-VMS based RMV data system. RMV controls the radar (function modes and antenna movements) and generates a 3-dimensional data cube volume to act as the base for 2-dimensional product data generation. Products are further sent to users via AFD. The existing VAX-RMV system has come to its final end of use because the system elements (hardware and software concept) are:

## Structure of Weather-Radars in Deutscher Wetterdienst



**Fig. 1.** RADRUM weather radar site system overview

- Difficult and expensive to maintain
- Limited by their low performance compared to currently available computers
- Limited with respect to new software developments and processing concepts for weather radar data

#### 1.4 The New RADRUM radar computer and software

The radar data processing of the German Weather Radar Network is currently being modernized by use of UNIX/LINUX-PC platforms and modern weather radar application software.

The GAMIC FROG-MURAN application suite is used as common software platform. Additionally to the requirements to appear unchanged and transparent with respect to the existing DWD radar site interfaces (“RMV-emulation”) FROG-MURAN has been extended by additional features and functionality, custom made for DWD according to project specifications.

The software system is capable to handle heterogeneous radar sensors of two different vendors which are currently operational in the DWD network. FROG-MURAN for the DWD has been designed to interface to existing and future hardware sensor concepts at DWD like digital receivers and dual polarization.

## 2 Main RADRUM project specifications

Figure 1 shows the main elements of the system elements installed at each weather radar site:

- C-Band weather radar sensor (Doppler and some non Doppler radars)
- Test signal generators (ITSG and DTSG) for calibration and BITE functions
- Radar Signal Doppler Processor – SDP
- RCC – Radar Control Computer
- The RADRUM Radar Computer and FROG-MURAN software
- Interface to the DWD AFD network

The existing interfaces between the Radar Computer and other devices had to be maintained in hard- and software function:

- Interface to the SDP’s–SCSI: control commands to the SDP and pre-processed data “rays” are communicated to the FROG-MURAN Radar Computer
- Serial line interface to the RCC: via serial line commands for radar function control and antenna movements are send/received to/from the RCC (Radar Control Computer). The test signal generator stimuli (ITSG

for radar reflectivity and DTSG for Doppler signals) are controlled via serial line and RCC. Radar status is monitored by means of BITE (built in test equipment) issuing status information via serial line.

- LAN interface to AFD: the standard TCP/IP interface to transfer products and for inter-platform communication (remote maintenance and supervision).

## 3 The new RADRUM system – features and advantages

The weather radar site processor for Radar control and generation of products is replaced by a new application suite based on UNIX/LINUX. A commercially available and proven software package FROG-MURAN was selected DWD in 2001 which has been adapted to the needs of DWD.

The main reasons of the DWD weather radar operational management personnel for the migration to a new data processing system were the following:

- The new software is intended to be used for the next 10 years.
- Additional future changes in the radar hardware and new product requirements need to be accommodated.
- Long term operational maintainability and availability of the software by migration from VMS (proprietary and outdated) to LINUX (open and non-proprietary)
- Seamless integration of FROG-MURAN with existing and commonly used weather radar systems
- Change to more precise and flexible data processing algorithm structures (products are directly generated from polar data) as more powerful platforms are available
- Short response time for realization of customer/user requirements as flexible software configuration and interfaces for post-processing are available in FROG-MURAN
- Modular software structures easily allow product generation remotely from radar sites – to be configured in the future (as fast data communication lines and compression algorithms are available now)
- Continuous upgrading and maintenance of the DWD software following the “mainstream-developments” at GAMIC allows for global software contracting (outsourcing)

These features will enhance significantly the DWD data quality with respect to precision, resolution in time and space, availability and flexibility. The scientific and operational bodies mainly in Germany but also in neighboring countries will profit from this new system at least in the next decade.

### 3.1 Data acquisition (FROG RT-MAS – MURAN)

#### 3.1.1 Frog RT

The Frog RT module performs all the functionality needed by the RC workstation. It is responsible for receiving data generated by the SDP, processing and then generating the resulting 3-D volume files. It is also responsible for the direct radar control and antenna movement according to the scheduled scans. The Frog RT has the following capabilities:

- Presentation of real-time radar data in the form of PPI, RHI, A-scope;
- Processing and visualization of radar BITE information;
- Visualization of antenna position: azimuth and elevation;
- Collection of radar rays from SDP at each antenna angle;
- Generation of 3-D polar volume RAW and BASE data (UZ, Z, V, W);
- Transmission of 3-D Volume to MAS-PROGEN;

FROG RDC provides local radar maintenance functions and utilities at radar site.

#### 3.1.2 FROG – MURAN

MURAN provides the communication infrastructure for product generation, distribution and remote radar control. It provides the following functions:

- Process and network support for all Frog applications;
- Distribution of templates for scan, product and schedule definition;
- Product distribution and remote radar control operations;
- FROG-RadarControl: Network Supervision and Radar-Control is responsible for displaying the current overall status of the system. The GUI's present the current state, radar status and BITE information along with the visualization of the system messages generated at the site.

#### 3.1.3 Product generation (FROG MAS-PROGEN)

Frog MAS provides full control of the radar, product definition and data acquisition control at radar site or at the remote center. MAS' installation consists of the following functions with their GUI's: DEAC, DEPRO, PROGEN:

- DEAC – Definition of acquisition, antenna scan and SDP parameter definition;
- DEPRO – Definition of production, product algorithm parameter definition, standard FROG and DWD specific products
- PROGEN – Generation of products, typically 2-D data are derived from 3-D polar data

### 3.2 Product display (COLIBRI II)

Frog VIS, the 2-D visualization is named COLIBRI II, is the main visualization tool for the weather radar operator. It provides the following functions:

- 2-D product visualization;
- Real-time and playback visualization modes;
- Visualization of stored images based on time/date selection;
- Product animation by displaying of a series of images;

### 3.3 Service tools (FROG RT)

The FROG RT maintenance tools are intended to automatically monitor and actively measure the correct function of the radar locally at site or remotely via a maintenance computer connected anywhere in the WAN. To mention just the most important functions:

- Control of the ITSG and DTSG for calibration
- Receiver noise measurement
- Antenna motion monitoring
- Antenna position alignment
- BITE message monitoring
- Data flux monitoring
- Process monitoring
- Monitoring of measurements quality

## 4 First results

As the new FROG\_MURAN system is currently under test and validation at MOHP (Hohenpeisenberg observatory).

A comparison of the new data system with the old one is under way and the conference presentation will comprise typical weather phenomena recorded with the new FROG Doppler Weather Radar software compared to RMV.